SW02-10

Polyester-Based Thin Films with High Photosensitivity, Kelly Simmons-Potter, Barrett G. Potter, Jr., David R. Wheeler, and Gregory M. Jamison (Sandia National Laboratories Albuquerque, NM 87185-1423)

A great deal of research has been done to understand the photosensitive optical response of inorganic glasses, which exhibit a permanent, photo-induced refractive index change due to the presence of optically active point defects in the glass structure. In the present work, we have performed a preliminary study of the intrinsic photosensitivity of a polyester containing a cinnamylindene malonate group (CPE, a photo- and thermal-crosslinkable group) for use in photonic waveguide devices. Thin films of CPE (approximately 0.5 microns thick) were spun onto fused silica substrates. Optical absorption in the thin films was evaluated both before and after exposure to UV radiation sources. It was found that the polyester exhibits two dominant UV absorption bands centered about 240 nm and 330 nm. Under exposure to 337 nm radiation (nitrogen laser) a marked bleaching of the 330 nm band was observed. This band bleaching is a direct result of the photo-induced crosslinking in the cinnamylindene malonate group. Exposure to 248 nm radiation (excimer laser), conversely, resulted in similar bleaching of the 330 nm band but was accompanied by nearly complete bleaching of the higher energy 240 nm band. Based on a Kramers-Kronig analysis of the absorption changes, refractive index changes on the order of -10^{-2} are estimated. Confirmation of this calculation has been provided via ellipsometry which estimates a refractive index change at 632 nm of -0.061 ± 0.002. Thus, the results of our investigation confirm the photosensitive potential of this type of material.

In addition, gratings were photoimprinted into the CPE film using a phase mask technique. To evaluate the thermal stability of these gratings, out-of-plane grating diffraction was observed and monitored during an isochronal thermal anneal sequence (up to 425 C) under flowing He. In contrast to the pure inorganic (germanosilicate glass) system previously investigated by our group, the organic material exhibited a marked decrease in grating contrast between 100 C and 300 C. We did observe grating persistence, however, to temperatures beyond 300 C which may indicate the formation of a surface relief grating or the compensating effects of thermally induced absorption modification within exposed and unexposed regions of the material.

In conclusion, we have observed an extremely high degree of photosensitivity in our polyester-based thin-film materials and, moreover, we have successfully demonstrated the formation of refractive index gratings in our films. UV-irradiation and thermal annealing effects on the optical absorption exhibited by the materials were found to be dependent upon the excitation wavelength used and the thermal history. These effects contribute to the grating thermal stability observed and, most likely, to the persistence of the gratings in our materials to temperatures > 300 C. The possibility of surface relief grating formation during photo-imprinting was recognized.

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